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Photon Number Resolving Superconducting Nanowire Single-Photon Detectors

Marco Colangelo

Northeastern University, Boston, Massachusetts, USA

E-mail: ma.colangelo@northeastern.edu

***Abstract*—The ability to resolve the number of photons of an optical field with precise timing and high fidelity is desirable for many applications, such as nonclassical state generation, quantum repeaters, quantum key distribution, linear optical quantum computing, metrology, and standard definitions.**

Superconducting nanowire single-photon detectors (SNSPDs) are currently the leading technology for single-photon counting at near-infrared wavelengths, with greater than 90% efficiency, sub-3 ps jitter, few-ns reset time, and sub-Hz dark count rate. However, unlike other superconducting detectors, due to their readout and operation modalities, they generally do not provide photon number resolution (PNR). Over the years, researchers have been engineering the architecture and operation of nanowire detectors to enable this missing capability and combine it with their high detection efficiency and timing resolution. In this presentation, I will review the techniques adopted to endow superconducting nanowire detectors with PNR capabilities. These include array-based architectures, pulse analysis, and various multiplexing schemes. I will then present our differential impedance-matched superconducting nanowire detector capable of resolving the photon number up to 5 photons and achieving state-of-the-art performances across all the metrics within the same single-pixel design. Finally, I will discuss the challenges and opportunities associated with scaling this technology, to produce a versatile, deployable detection technology.

***Keywords (Index Terms)*— Superconducting Nanowires, Single-photon detectors, SNSPDs, Photon-number Resolution, Nanofabrication**

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